

What is claimed is:

1. A lead-free solder comprising 0.05 - 5 mass % of Ag, 0.01 - 0.5 mass % of Cu, at least one of P, Ge, Ga, Al, and Si in a total amount of 0.001 - 0.05 mass %, 0 - 0.1 mass % in a total amount of one or more transition elements, 0 - 5 mass % of at least one of Bi, In, and Zn, 0 - 1 mass % of Sb, and a remainder of Sn.

2. A lead-free solder as claimed in claim 1 wherein the amount of Cu is at most 0.3 mass %.

3. A lead-free solder as claimed in claim 2 wherein the amount of Cu is at most 0.1 mass %.

4. A lead-free solder as claimed in claim 1 which includes one or more transition elements in a total amount of at most 0.1 mass %.

5. A lead-free solder as claimed in claim 1 which includes at most 5 mass % of at least one of Bi, In, and Zn.

6. A lead-free solder as claimed in claim 1 which includes at most 1 mass % of Sb.

7. A solder bump comprising a lead-free solder as claimed in claim 1.

8. A BGA package including a substrate, a semiconductor chip disposed on a first side of the substrate, and a plurality of solder bumps comprising a lead-free solder as claimed in claim 1 formed in an array on a second side of the substrate and electrically connected to the semiconductor chip.

9. A lead-free solder ball comprising a lead-free solder as claimed in claim 1.

10. A method of forming soldering bumps comprising placing solder balls comprising a lead-free solder as claimed in claim 1 on a substrate and heating the solder balls to melt the solder balls and form them into solder bumps secured to the substrate.

11. A method as claimed in claim 10 including previously preparing the solder balls by dropping pieces of the lead-free solder into a hot oil bath to form the pieces into spheres.

12. A method of forming solder balls comprising dropping pieces of a lead-free solder as claimed in claim 1 into a hot oil bath to form the pieces into spheres.